Using Advanced Scientific Diving Technologies to Assess the Underwater Environment

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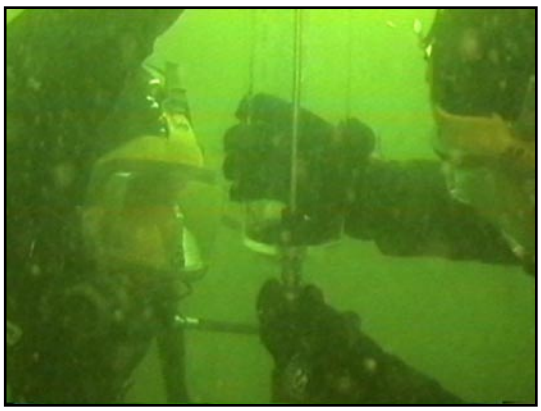
Abstract
Scientific diving is an important tool that can provide unique information for addressing complex environmental issues in the marine environment. The Pacific Northwest National Laboratory (PNNL), Battelle Marine Sciences Laboratory uses trained scientific divers in conjunction with advanced technologies to collect *in-situ* information best obtained through direct observation requiring minimal environmental disturbance. Diving operations are applied to a variety of increasingly important issues throughout Puget Sound, including habitat degradation, endangered species, the effects of overwater structures and shoreline protection, and biological availability of contaminants. For example, advances in underwater communications allow divers to discuss observations and data collection techniques in real time, both with each other and with personnel on the surface. Other examples include the use of digital sonar (DIDSON) an underwater camera used to capture digital images of benthic structures, fish, and organisms during low light and high turbidity levels; the use of voice-narrated underwater video, and the development of sediment collection methods yielding one-meter cores. The combination of using trained scientific SCUBA divers and advanced underwater technologies is a key element in addressing multifaceted environmental problems, resulting in a more comprehensive understanding of the underwater environment and more reliable data with which to make resource management decisions.

Introduction
Scientific diving is a tool that provides unique information for addressing complex environmental issues in the marine environment. As part of the Pacific Northwest National Laboratory system, Battelle Marine Sciences Laboratory (MSL) scientific divers field test and utilize advanced technologies to collect *in-situ* information that is best obtained through direct observation with minimal environmental disturbance.

Field Testing New Technologies
The MSL Scientific Dive Team recently tested the DIDSON (Dual Identification Digital Sonar) developed by the Applied Physics Laboratory at the University of Washington. This device uses sound waves to generate real-time images in low-visibility conditions (e.g., high turbidity and at night). We tested this device for fisheries research applications and used it to detect juvenile salmonids in the marine environment at night, although these images only depict size and shape, we were able to infer species identification based on field observations. We are currently testing a new cost-effective reusable acoustic release buoy (aka ARBY) developed by Tech_Xpert LLC/ Sudon Enterprises. This remote-controlled system releases a pre-deployed tethered float to the surface. This technology will allow divers and surface personnel to quickly relocate instrument packages and/or specific points of interest in shallow subtidal waters to depths of 100 feet.

Instrument Deployments and Recovery
Scientific divers can collect a wide variety of information from the underwater environment, as well as the sediment, water column, or tissue samples, using state-of-the-art data loggers, sampling devices, and collection techniques for further analysis. Instruments routinely deployed for environmental sampling underwater include multi parameter data loggers, flux chamber gas collection devices, sediment traps, Photosynthetically Active Radiation (PAR) sensors, sediment cores collection devices, and peizometers. Scientific divers can ensure scientific instruments are positioned correctly to collect the suite of information required to answer a specific question.



Visual Information

"A picture is worth a thousand words." This is especially true in the underwater world. Video and still photography relay events and conditions beneath the surface. The images tell a story and provide insight to issues at hand, especially when a time series is taken over days, months, or years. Images also provide a visual record for identification of species, habitats, and substrate with minimal disturbance to the marine life or the surrounding environment.

Advances in Underwater Communication

Divers now have the ability to communicate with each other and with surface personnel using single sideband wireless transceivers. This greatly enhances the divers' ability to discuss observations in real-time and allows them to relay those observations to surface scientists, equipment operators, and sponsors. This allows research divers to adapt to changing conditions, discuss probable courses of action, relay qualitative and quantitative data to the surface for recording, and increase overall project efficiency and safety.

Summary

Using scientists with advanced SCUBA training in combination with advanced underwater technologies produces a more comprehensive understanding of the underwater environment and more reliable data with which to address multifaceted environmental problems and make resource management decisions.